

WATER VAPOR PROFILING USING MICROWAVE RADIOMETRY

by

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Water vapor is one of the most important constituents in the Earth's atmosphere. Its spatial and temporal variations affect a wide spectrum of meteorological phenomena ranging from the formation of clouds to the development of severe storms. It provides an important input to tropical numerical weather prediction and energy budget studies, because the latent heat release due to condensation is crucial to the evolution of many tropical weather systems and is an important energy source to the global scale Hadley and Walker circulation cells. These considerations point to the need for effective and frequent measurement of the distribution of atmospheric water vapor, and therefore, the need for the development of efficient remote sensing techniques. The passive microwave technique offers an excellent means for water vapor measurements. It can provide both day and night coverage under most cloud conditions.

Two water vapor absorption features, at 22 and 183 GHz, have been explored in the past years. The line strengths of these features differ by nearly two orders of magnitude. As a consequence, the techniques and the final products of water vapor measurements are also quite different. At 22 GHz the atmosphere, in clear conditions, typically absorbs less than 20 percent of the radiation propagating through it. Most of the attempts to retrieve water vapor by remote measurements near this frequency

are, therefore, limited to total precipitable water. On the other hand, the strong absorption line at 183 GHz offers the potential of profiling the atmospheric water vapor. In fact, all the past studies of this absorption feature for remote sensing application have emphasized the retrieval of atmospheric water vapor profiles. Our effort in the early 1980's concentrated on the development of both sensor technology and retrieval algorithms at 183 GHz for profiling atmospheric water vapor. The Airborne Microwave Moisture Sounder (AMMS) was the result of this sensor development effort. Using this sensor, retrieval of water vapor profiles under clear sky conditions was successfully demonstrated. As a result of this combined science and technology program, this approach to the measurement of water vapor profiles is currently being implemented for both the NOAA and DMSP satellites and is also planned for inclusion in the Eos payload.

Our research effort in the past few years has been to improve and extend the retrieval algorithm to the measurements of water vapor profiles under cloudy conditions. In addition, the retrieval of total precipitable water using 183 GHz measurements, but in a manner analogous to the use of 22 GHz measurements, to increase measurement sensitivity for atmospheres of very low moisture content was also explored. A combination of both these techniques was used to retrieve the total precipitable water over the coastal Atlantic Ocean during a cold air outbreak which was observed by the AMMS on board the NASA ER-2 aircraft during the 1986 Genesis of Atlantic Lows Experiment as shown in figure 1.

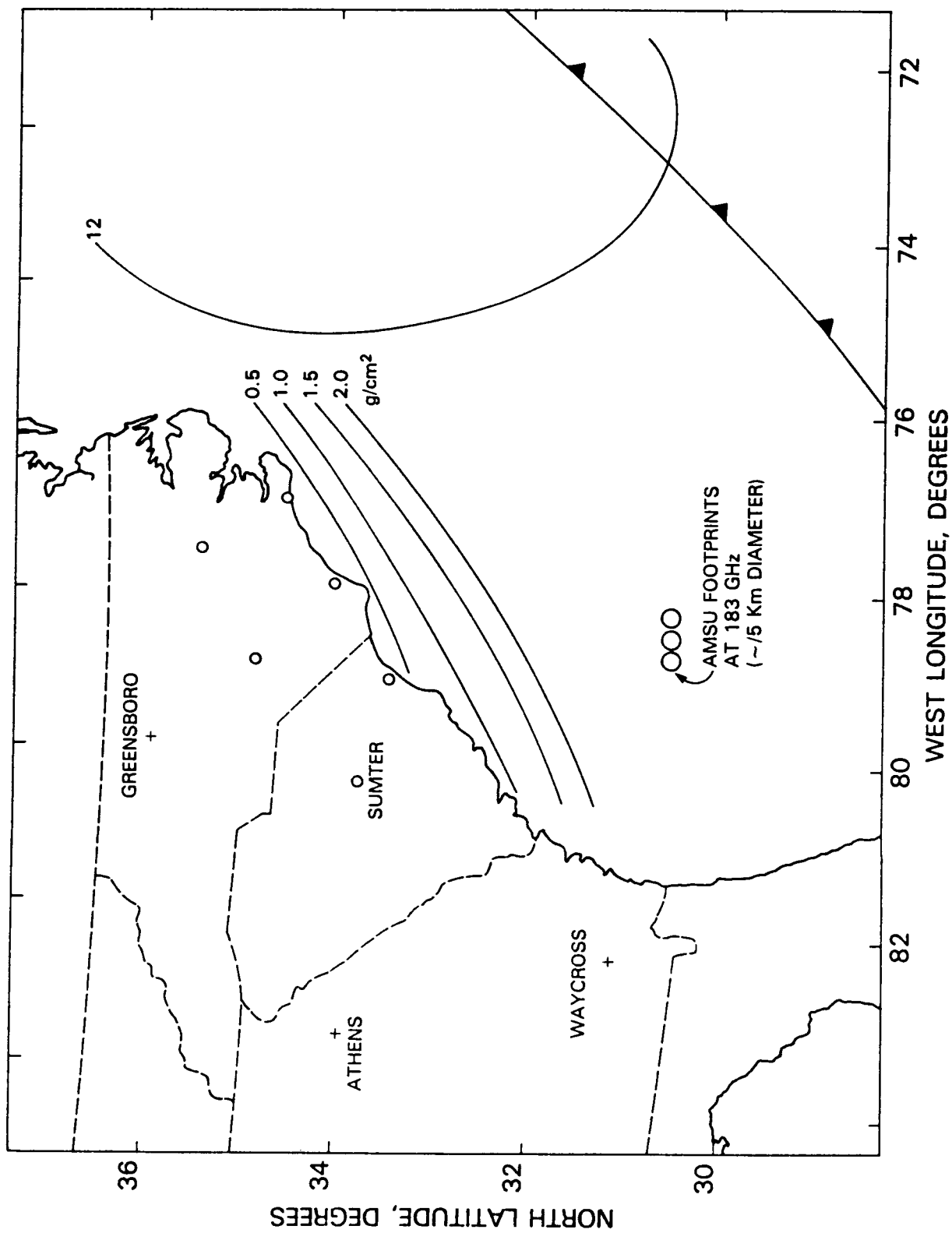


Figure 1. 1986 Genesis of Atlantic Lows Experiment